

## Role of satellites in monitoring sediment dynamics

Image recorded by sensors onboard the satellite is fast, economic and efficient in providing information about various earth features. A passive remote sensing system records the electromagnetic energy naturally radiated or reflected from an object. Visible wavelength images can be particularly useful in coastal studies since their penetration of water column enables measurements of water quality parameters such as turbidity, suspended sediment concentration and chlorophyll, while infrared observations can be important in studying the dispersion of out-fall plumes and offshore circulation. Monitoring and understanding sediment dynamics are vital components to solve coastal engineering problems. As satellites are able to provide information on sediments, in the present study capability of remote sensing technique in monitoring sediment dynamics was demonstrated.

Vedaranyam, the study area is located

in the southeast coast of India and has a peculiar projection, which is of interest for geologic and geomorphic studies (Figure 1). Tamil Nadu coast experiences a climate strongly influenced by the southwest (June–September) and northeast (October–December) monsoons. Formation of Point Calimere projection is due to two constantly opposing wave directions, such as northeast and southeast, with one set of waves predominant over the other. Further, the foreland formation is determined by the rate at which the stream delivers the sediment and the rate at which the waves can winnow and move the sediments in either direction away from the mouth. The coastline is consequently affected predominantly by waves from the northeast. This is clearly reflected by the shape of the foreland, which has veered windward.

Yarger *et al.*<sup>1</sup> had suggested that the band ratio of Multi Spectral Scanner

(MSS) 5/4 was suitable only for low sediment concentration while 6/4 and 7/4 display good correlations for low as well as high concentration. Collins and Pattiaratchi<sup>2</sup> showed that with Airborne Thematic Mapper (TM) data, low and high sediment concentrations were best represented in the 450–520 nm and 605–625 nm wavelengths, respectively. False Colour Composite (FCC) generated with MSS band combination of 4, 2 and 3 better manifest the pattern and concentrations of suspended sediments.

As the main focus of the study was to prove the capability of satellite in predicting sediment distribution pattern, LANDSAT data representing different monsoon seasons were selected. As the sediment distribution pattern is controlled by currents, which are season specific, and remains the same for each season irrespective of the year, data on different years will not affect the aim of the study. The digital data analysed in the present study are shown in Table 1. As data belong to the past years, synchronous sea truth data could not be collected to correlate the sediment with reflectance values.

Principal component analysis achieves overall ground cover enhancement by selecting the best information from the raw data and at the same time reducing the dimensionality of the data without much loss of information. Hence the above raw digital data were subjected to image processing analysis – Principal component technique, using VIPS 32, Digital Image Processing software to enhance the sediments in suspension. A similar technique was adopted by Dean *et al.*<sup>3</sup> to analyse the plume of the Yukon River into the Bering Sea.

Sediment distribution at Vedaranyam during different seasons is depicted in Figure 2 a–c. From the figures, the direction of sediment movement can be clearly identified. Sediments move towards north during southwest monsoon (Figure 2 a, b) and vice versa during northeast monsoon (Figure 2 c). As the sediments are transported by the longshore currents, the directions indicate the movement of currents. The above observations from satellite data agree with the longshore current direction perceived through conventional methods by Natesan<sup>4</sup>.

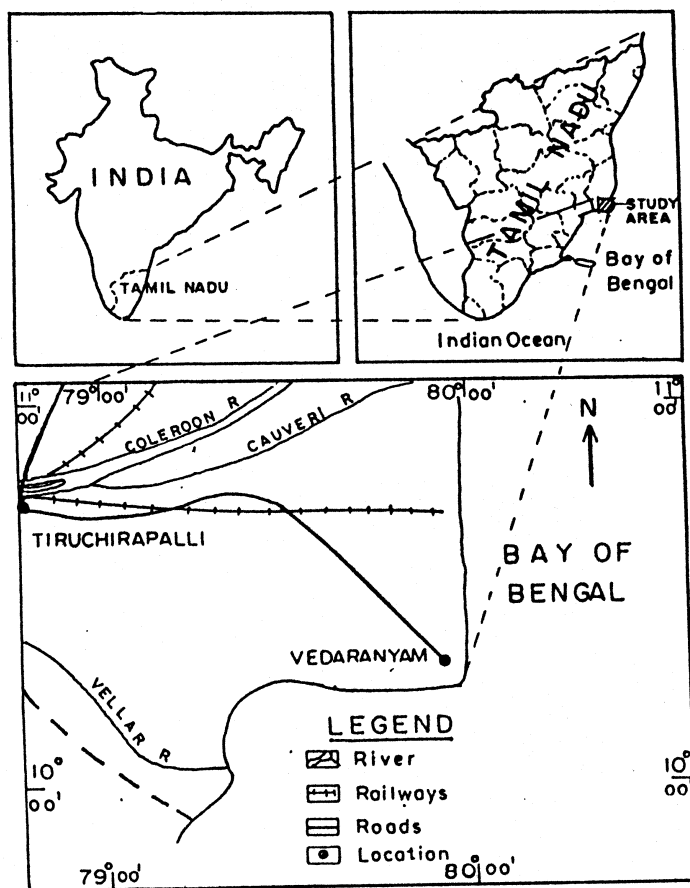
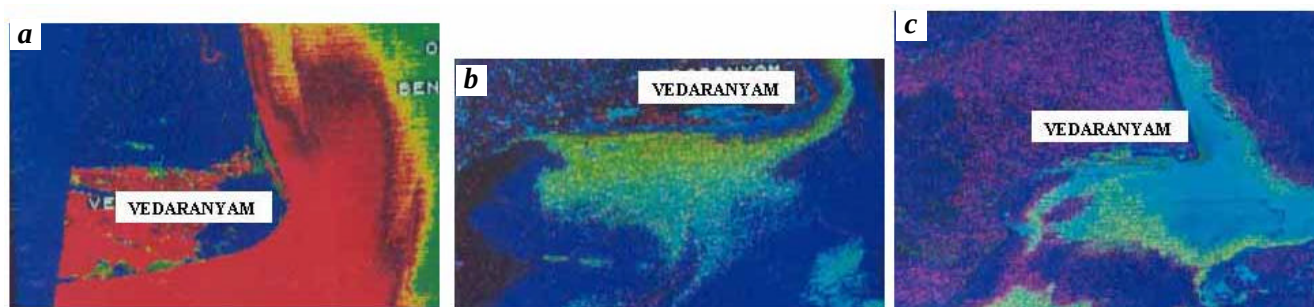


Figure 1. Study area.



**Figure 2.** Sediment distribution (a) at the onset of southwest monsoon; (b) at the end of southwest monsoon; (c) during northeast monsoon.

**Table 1.** Data products used

| Date of acquisition | Sensor | Bands       | Season                     |
|---------------------|--------|-------------|----------------------------|
| 13-06-1988          | TM     | 3           | Onset of southwest monsoon |
| 28-09-1983          | MSS    | FCC 4, 2, 3 | End of southwest monsoon   |
| 23-11-1989          | MSS    | FCC 4, 2, 3 | During northeast monsoon   |

With the onset of southwest monsoon, sediments were disturbed considerably (Figure 2a). Tidal flats at Vedaranyam acting as a source for sediment is clearly identified from the image. Daniel<sup>5</sup> observed that the sediments are discharged from tidal flats due to soil erosion. The retreat of seawater eroding the banks of tidal flats contains high amount of sediments in suspension. This appears bright red in colour around the mouth of tidal flats. As the sediments move towards the north due to the longshore currents, their concentration is reduced which is indicated by yellow colour in Figure 2a. At the end of the southwest monsoon, initial disturbances are very much reduced. Sediments moving towards the north are obstructed by the projection at Vedaranyam (Figure 2b). Therefore, it takes a turn near that tip and then follows the coastal configuration.

In contrast, during the northeast monsoon season, sediments transported from north are unable to take a bend around the Vedaranyam tip and hence dissipate a greater part of it (Figure 2c). A portion of the sediment is moving towards the east and the rest of it moves downsouth of Vedaranyam along with the longshore currents.

From the conventional data seasonal sediment distribution patterns in near-shore/offshore are almost impossible to obtain. Satellites are the only source of providing such information. The present study proves that the satellites play a significant role in monitoring the sediment dynamics.

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Received 23 June 2003; revised accepted 17 January 2004

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## Laboratory colonization of *Anopheles sundaicus*

*Anopheles sundaicus* Rodenwaldt, belonging to subgenus *cellia*, is an important vector of malaria over the range of its distribution. The distribution ranges from the Indian subcontinent through Southeast Asia including Myanmar, Thailand, Malaysia, Singapore, Indonesia and China<sup>1</sup>. In India it was an important vector of malaria in coastal areas of Andhra Pradesh, Orissa, Tamil Nadu, West Bengal and the Andaman and Nicobar islands<sup>2-4</sup>. How-

ever, during the DDT spraying era under the National Malaria Eradication Programme, this species disappeared from the eastern coast of India and is now limited to the coastal areas of Andaman and Nicobar Islands. In Andaman and Nicobar group of islands, this species presently plays a major role in malaria transmission<sup>5</sup>.

A wide variation in the breeding habits, resting and feeding behaviour of *An.*

*sundaicus* has been reported in areas of its distribution and because of these differences this species was suspected to be a cluster of closely related species. Cytotaxonomic studies carried out on *An. sundaicus* populations from Thailand and Indonesia established this species as a complex of three isomorphic species (species A, B and C) identifiable on the basis of cytological and enzymatic variations<sup>6,7</sup>. More recently, studies on *An.*